

Development and Assessment of an Oscillatory Motion Tutorial

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Introduction

- Interpreting graphs is critical for developing an understanding of many topics in physics (McDermott, 1987)
- Our previous research has found students have difficulty extracting information from graphical representations.
- Goal: Create a short tutorial to improve student understanding of mathematical and graphical representations of oscillatory motion.**

Methods

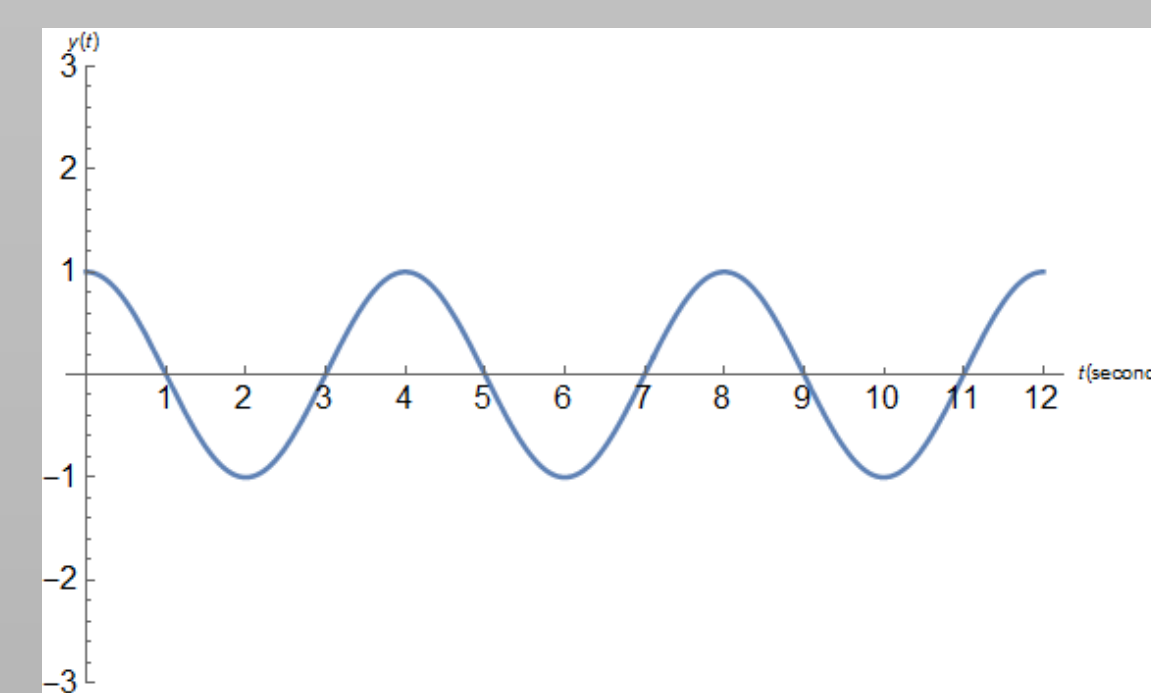
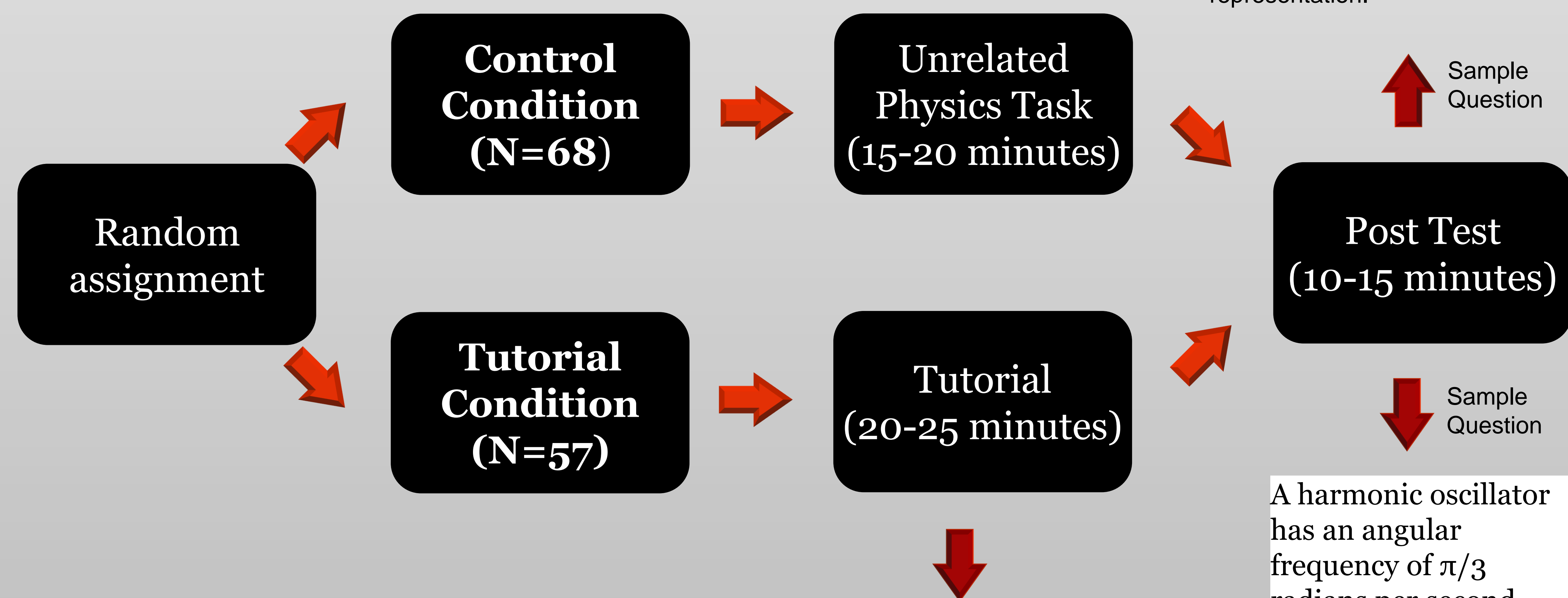
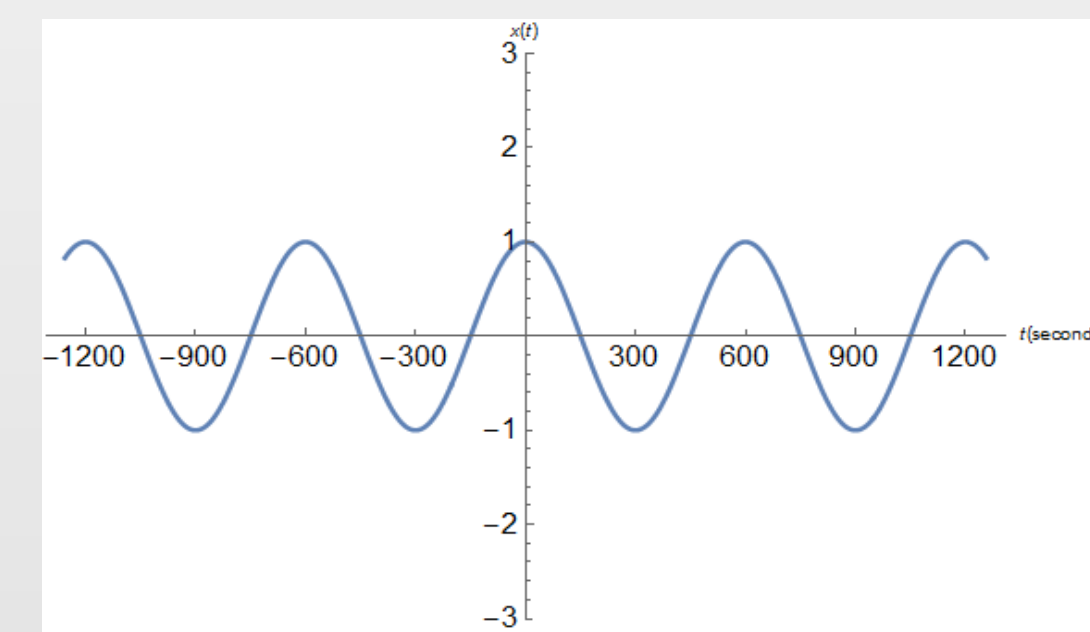


Figure 1: Sample question on the tutorial requiring students to explicitly connect graphical and mathematical representations

The above graph depicts the motion of a mass on a spring moving along the y-axis.

- Using the above graph, what is the period of the mass on the spring?
- Using the above graph, what is the frequency of the mass on the spring?
- Using an equation, calculate the frequency using the period from part a.
- Are your answers to part b and c the same?
- Using the above graph, what is the angular frequency?
- Using an equation, calculate the angular frequency using the period from part a.
- Using an equation, calculate the angular frequency using the frequency from part b.
- Are your answers to parts e-g the same?



- What period is depicted in the above graph?
- What frequency is depicted in the above graph?
- What angular frequency is depicted in the above graph?

Figure 2a: Sample question on the post-test involving a graphical representation.

A harmonic oscillator has an angular frequency of $\pi/3$ radians per second. Determine the frequency and the period of the harmonic oscillator.

Figure 3a: Sample question on the post-test involving a mathematical representation.

Results

Question Results

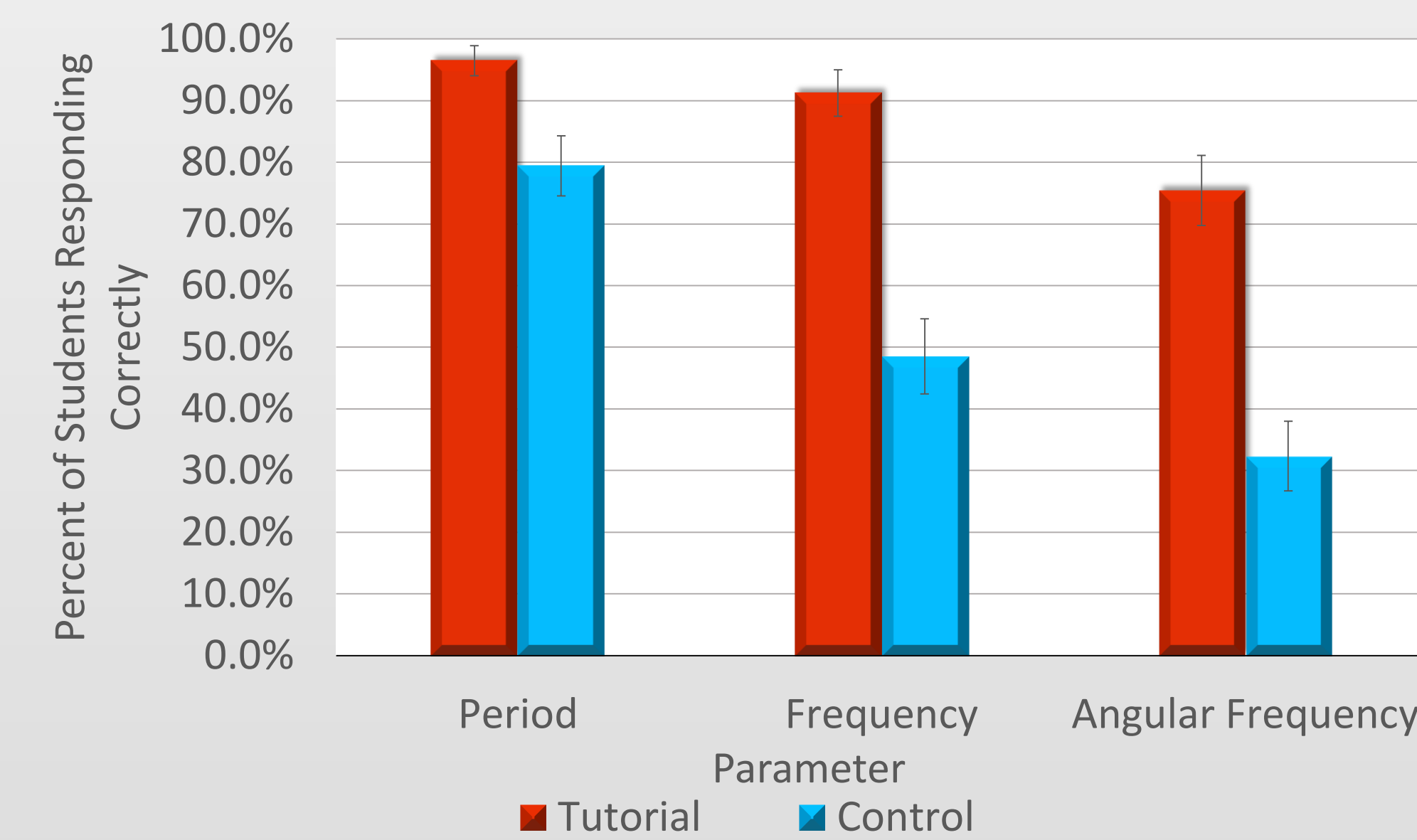


Figure 2b: Student performance on the question depicted in figure 2a. The results are representative of similar questions on the post-test. Error bars are ± 1 S.E.

Overall Results

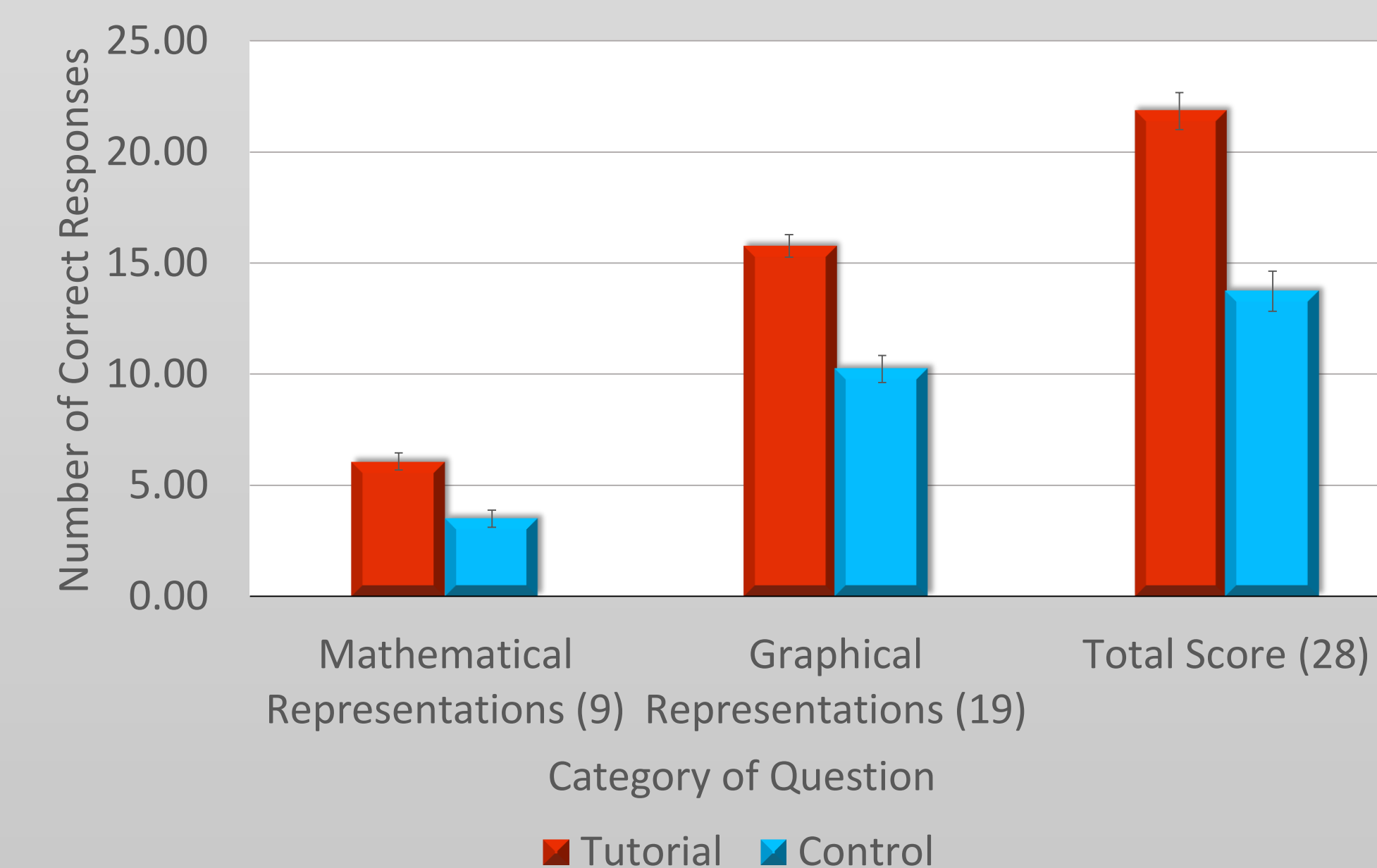


Figure 4: Overall student performance on the post-test. Mathematical representation questions are those similar to questions shown in figure 3a while graphical representation questions are those similar to the question shown in figure 2a. The number in parentheses is the number of questions in the category. Error bars are ± 1 S.E.

Question Results

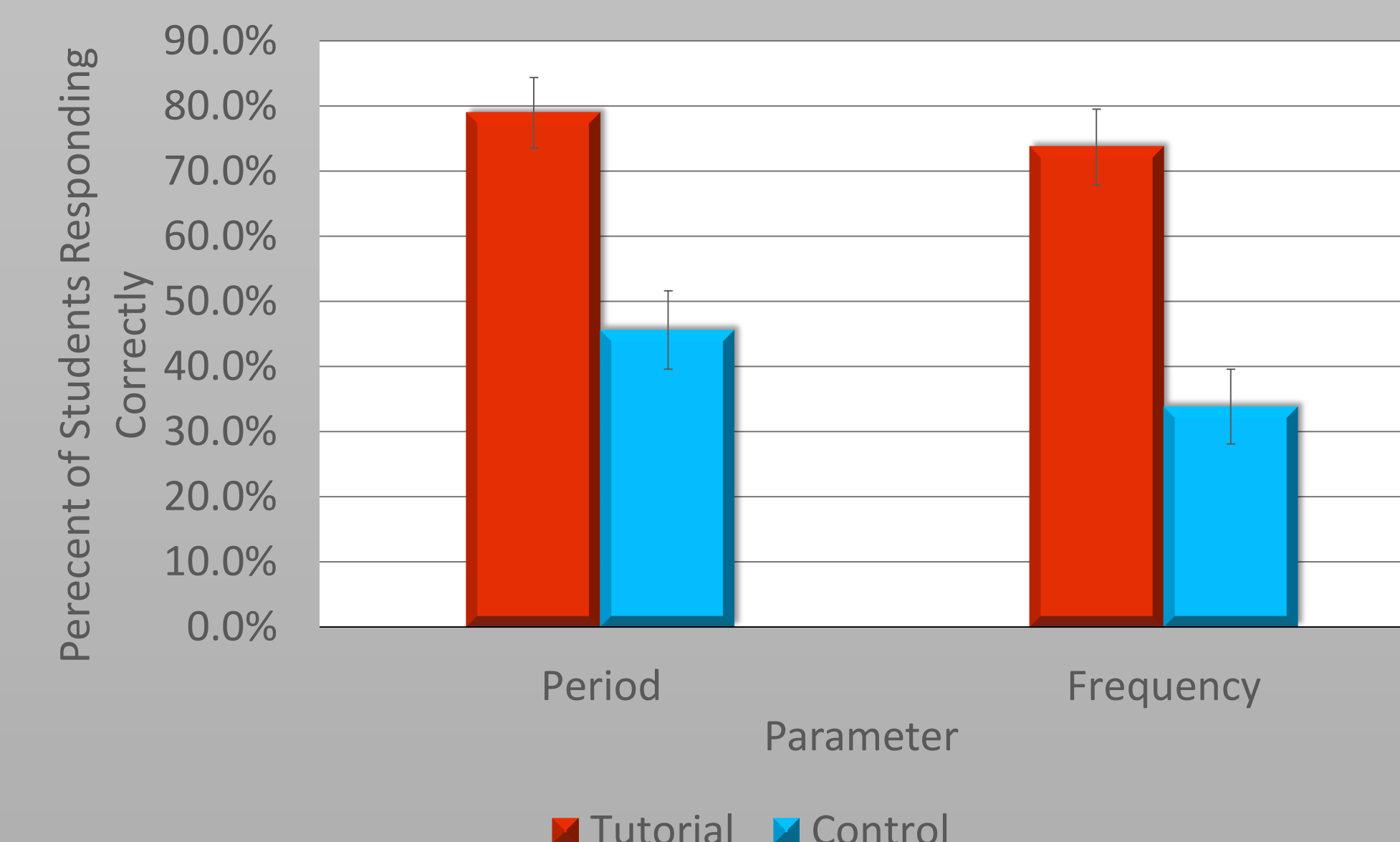


Figure 3b: Student performance on the question depicted in figure 3a. The results are representative of similar questions on the post-test. Error bars are ± 1 S.E.

Conclusions

- Overall, post-test performance in the tutorial condition was significantly greater than in the control condition** ($t(123)=6.568$, $p<.001$).
- Corresponds to substantial effect size ($d=1.17$)
- Students in the control condition and tutorial condition both did best on questions involving the period and worst on questions involving the angular frequency.

Future Research

- Investigate the relation between student understanding of graphical representations and mathematical representations.
- Investigate possible hierarchies between determining the period and frequency from graphical and mathematical representations.
- Incorporate the tutorial into our online practice application for introductory physics students.

Acknowledgements

I would like to thank Nathaniel Amos, Ryan Badeau, Abby Bogdan, Hanna Lafranconi, and Daniel White for their assistance and feedback throughout this project.

- Students worked in groups of 3
- Our previous research found students understand period best.
- Tutorial used student's knowledge of period to help them understand frequency and angular frequency.
- No feedback from researcher.